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**Estimates of effort, CPUE, and mean length for the Norwegian commercial catch of ling, blue ling and tusk**

by

Kristin Helle and Michael Pennington

Institute of Marine Research,  
P.O. Box 1870 Nordnes, N-5817 Bergen, Norway  
E-mail: [kristin.helle@imr.no](mailto:kristin.helle@imr.no)

**Introduction**

Ling, tusk and blue ling have been fished by Norway for centuries and the amounts landed have been recorded since 1896 (Figure 1). The major fisheries for these species are taken by long lines, and the catches are to a large degree bycatches. The fishery for these three species is mainly influenced by the size of various quotas for other species, especially the quota for Arcto Norwegian cod. Therefore the total catch may not be a good indicator of the state of these stocks (Figure 2). Scientific surveys do not cover the main habitats of these species. Consequently, to estimate the relative abundance of these stocks, indicators such as CPUE series need to be generated. In order to construct CPUE series, the Institute of Marine Research (IMR), in cooperation with the Norwegian Directorate of Fisheries (NDF), began in 2003 to record in an electronic database the logbooks of long liners larger than 21 m. Vessels were selected that had a total landed catch of ling, tusk and blue ling that exceeded 8 tons in a given year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. To obtain more detailed and targeted information, the IMR initiated in 2000 a program to collect data and biological samples directly from selected commercial long-liners, the so-called “reference fleet.” The fishers measure a subsample of fish at selected locations. Upon request they may also collect otoliths, stomachs, tissue for genetics, and other biological samples. Presently four long-liners are members of the reference fleet.

This paper presents time-series of effort and CPUE from these two data sources and compares the 2000-2009 data with previously submitted data for the period 1972-1994. It also gives estimates of the mean length of ling, tusk and blue ling during the two periods.

Only about half of the 2009 logbooks from the fleet have been entered so far and the estimates are therefore preliminary.

**Development of the Norwegian fleet of long-liners, 1995- 2009**

In addition to data on total landed catch\*, the NDF also provides data on how many of the fishing vessels satisfying the above criteria are at any time participating in the

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\* The data provided by the NDF are; the total landed catch, the logbook data, and the catch at a location.

fishery, the gear employed, areas fished and changes in vessel ownership. Table 1 provides information on the number of long liners during the period 1995 to 2009, the total landed catch by the fleet, and the average annual catch per vessel. The number of vessels peaked in 2000 and then decreased until 2006. After 2006 the number of vessels seems to have stabilized. The number of vessels declined during this period mainly because of changes in the laws concerning quotas for catching cod. The decrease in vessels was followed by a reduction in the total catches until 2004, after that there was an increase in total catch, especially in 2007 and 2008 (Figure 2a). The catch-per-vessel was relatively stable from 1995 until 2003. After 2003 there was a steady increase in catch-per-vessel (Figure 2b). In 2000 there were 72 vessels in the fishery; by 2006 the number had dropped to 35, and in 2009 the number decreased to 34.

### **Logbooks**

All available logbooks for the years 2000-2008 have now been entered in the database and the data have undergone extensive quality control procedures. The entering of the logbooks from 2009 are the estimates are therefore based on a subset of logbooks. The quality of the logbooks varies considerably and a serious problem is that some lack information on the number of hooks used per day.

### **Days in the fishery**

The Norwegian long line fleet logbooks provide information on the geographical distribution of the fleet. In Table 2 the average number of days a vessel spent in a given area fishing for tusk, ling and blue ling jointly and separately is given for all ICES Subareas and Divisions. After 2000, when new quota laws for cod were introduced, the number of days each vessel fished for the three deep-water species increased and by 2005 and 2007 the number of days in the fishery was twice that in 2000. The data for 2006 show that the number of days in the fishery has decreased by more than 20 percent compared with the number in 2005 and 2007. Although the number of vessels was at its lowest in 2006 (35 vessels) this reduction in the number of vessels is not sufficient to explain the decrease number of days in the fishery. The data have been checked for errors but none have been discovered. Division IIa was the main fishing area since 2000, followed by IVa and Vb.

### **Average number of hooks used per day**

Table 3 provides estimates of the average number of hooks used per day in different areas and in the total fishery for the years 2000-2007. For all areas combined there was a steady increase in the number of hooks used from 2000 through 2007. This is also the overall trend for the subareas (Figure 2).

### **Total number of hooks per year**

Based on the number of vessels, the number of hooks per day, and number of days each vessel participated in the fishery, estimates of the total number of hooks used per year were generated (Tables 1, 2 and 3). Table 4 gives the estimated number of hooks (in thousands) set in each of the ICES subareas and in the total fishery for the years 2000-2007. Although the number of vessels has decreased considerably, the total

number of hooks has remained remarkably stable during the period 2000-2007, except for 2006 when there was a slight decrease (Figure 4).

### **CPUE from log books and the reference fleet**

In Tables 5 and 6 are estimates of the catch-per-unit of effort (CPUE) based on the logbook data and data from the reference fleet. The measure of CPUE is the average weight (kg) of fish caught per 1000 hooks. Figure 5 shows the variation in the CPUE for ling and tusk in each ICES subarea and in all areas combined. For tusk there was a slight downward trend in most of the subareas from 2000 to 2003, then an increase from 2004 to 2006 and a slight decrease in 2007. This is especially apparent in areas Vb and VIa. For ling there was a slight downward trend from 2000 through 2002, an upward trend from 2003 through 2005 followed by a slight decline in 2006 and 2007.

Entering the data from the logbooks for the entire fleet is time consuming and laborious. It has therefore been suggested only to use the data from the reference fleet. Figures 6 and 7 show the CPUE estimates from the logbook vs. the reference fleet for tusk and ling. The reference fleet does not cover the entire area in which the long liner fleet is fishing and, hence, data for the more “remote” areas are absent or inadequate (see Tables 5 and 6). Only the main fishing grounds in area IIa are sufficiently covered to achieve reliable CPUE estimates. To get good estimates of CPUE for the entire fishing area, data from the logbooks are necessary.

### **Historical data vs. new data**

In the 1990s a Nordic and a Norwegian project studied the fishery, age distributions and general biology of ling, blue ling, and tusk in the Northeast Atlantic (Bergstad and Hareide, 1996; Magnusson *et al.*, 1997). These projects greatly improved our knowledge of these species and formed an important foundation for further studies. The results from these studies were presented at earlier WGDEEP meetings, and the Group used analyses of time-series for the Norwegian long liners back to 1972 for effort and CPUE as a basis for assessing abundance trends. In the present study, the 2000-2007 data and the earlier time-series were combined.

In the 1990s the data for the Norwegian fishery were derived from two sources; official logbooks from the NDF, and private logbooks submitted voluntarily by selected vessels. It was shown in Bergstad and Hareide (1996) that the official data and the private data were very similar, and that the much longer time-series from the skipper's logbooks provided reliable data on catch trends. It should be noted that the effort data were corrected for all known technological changes to account for changes in efficiency (see report for details).

A time series of CPUE was made from the early 1970ties until the mid 1990ies. The series was based on private log books, official logbooks and data from the Norwegian Directorate of Fisheries. This series showed a drastic reduction in CPUE during this period and had been used as an indicator for a severe reduction of the ling and tusk population. The time series was never published and the documentation of the results are hard to find because the data used is not available and a number of the tables in

the unpublished document describing this work is missing. When using these data there are a few points I want to discuss.

The number of hooks was as far as I can find out based on logbooks from three vessels. Each of these three vessels had their main fishery in different parts of the distribution areas for ling and tusk.

1971-1993: Three vessels were chosen because they cover typical fishing strategies of the fleet. Vessel 1 concentrated the effort in Faroese waters but fished occasionally in other areas. Vessel 2 was mainly fishing off the Hebrides and on the Rockall bank.

Vessel 3 was mainly fishing off Shetland and occasionally in other areas.

There is no information about the number of official logbooks that were used. But based on knowledge about the reference fleet and the large variation in the estimates from year to year the number was probably low.

Change from handbated lines to autoline:

During the time period this series covers the fleet changed a lot and went from hand baited lines to auto lines. Although both are lines the way they are

Hand baited lines are much more labor intensive and is therefore set more careful than autolines

Hand baited lines are much shorter and is set in known “hot spots” while autolines are longer and often stretched from hot spot to hot spot.

Fresh bait was often used on the hand baited lines while frozen bait is used on autoline, fresh bait stays on the hooks better than frozen.

These data were combined with the data for 2000-2006 (Figure 10). The number of hooks used per day showed a steady increase from the early 1970s, and based on the recent data it appears that the upward trend continues (Figure 10a). Compared with 1972, the fishers presently set three times as many hooks per day. The total number of hooks used per year showed an increase from the early 70s until the early 80s.

Subsequently both the old and new data showed large year-to-year variation but no apparent trend. The total number of weeks used in the fishery declined through the entire period (Figure 10b). The new data indicate that the number of weeks in the fishery during the period 2000-2007 has stabilized at the same level as in 1994 (approximately 1100 weeks) with a decrease in 2006 to about 800 weeks.

Figure 11 shows the CPUE ( $[\text{kg}/\text{hook}] \times 1000$ ) for ling, tusk and both species combined for the periods 1971 through 1993 and for 2000 through 2007. CPUE declined for both species and this decrease is especially noticeable for ling. The recent data suggest that the CPUE has remained at a low level after 1993 with an increase during the period 2003-2006 and a decline in 2007.

Figure 12 shows the recent and the historical CPUE for tusk in all areas and in areas IIa, IVa, Vb, VIa and VIb. When the tusk data were not combined with ling it is obvious that there was a declining CPUE series in the historical period. The low CPUE levels appear to continue in the recent period, although from 2004 through 2006 there was an apparent increase in CPUE.

Based on the results from the genetic analysis of tusk, which show that the Rockall population is separate from those in the other areas (Knutsen *et al.*, 2007), it is of interest to examine separately the CPUE in each subarea. For some of the areas there

are probably insufficient data to analyse trends in CPUE. This is especially apparent for area IIa where no obvious trend is apparent in the historical data. The recent data indicate a decline during the years 2000-2004, an upward trend in 2005 through 2006 and again a small decline in 2007. In areas IVa, and VIa the historical data indicate a decline in abundance while there was an upward trend recently. In Area Vb there was a sharp decline in CPUE from 2006 to 2007. In area VIb, no trend is apparent during the historical or the recent period. The Norwegian fishery in this area was limited

In Figure 13 both the new and the historical CPUE data for ling in all areas and in areas IIa, IVa, Vb, VIa and VIb are presented. The historical data indicate a downward trend. The recent CPUE estimates continue at the same low levels as was observed in 1993. The recent data showed an upward trend for areas IVa and Vb for the years 2002 through 2006 with a decline in 2007. In area VIb there has been a continuous positive trend from 2002 through 2007. For area IIa there was an upward trend from 2001 until 2005 and then a decline in 2006 and 2007. Since the late 1970ies until the present there was no apparent trend in area VIa.

### **Estimated lengths of ling, tusk and blue ling**

The method for estimating the average length is given in Helle et al., (2006). In Tables 7, 8 and 9 are estimates of the average length of ling, tusk and blue ling in the commercial catch. The estimates of mean length for 1976-1995 are taken from Bergstad and Hareide (1996). During the years 2001, 2002 and to a lesser extent 2003, the reference fleet did not record the total catch from which the subsamples were taken and, therefore, the unweighted mean (eq. 2) was calculated for 2001, 2002 and for areas V and VIb in 2003 and the weighted mean (eq. 1) for the other years and areas. These estimates are in Tables 1, 2 and 3, along with sample size and estimated standard deviation (previous measurements) and standard errors for the reference fleet estimates. The estimates of mean length varied slightly from year to year but with no obvious trend.

### **Conclusion**

Given that other sources of information are lacking, the CPUE estimates may constitute the only source of information on temporal trends in abundance. It is a notable result that even though the catch-per-vessel increased during the period 2004-2008, the abundance as indicated by CPUE in the most important fishing area, subarea IIa, may be constant or even declining. For the remaining areas the results were more positive. Even though there is a time gap of six to seven years between the old and the new time series, the recent CPUE estimates seem to correspond and reflect the trends in the fishery quite well. The main pattern is that CPUE remains at a low level compared with the 1970ies and 1980ies.

Legislation to regulate the cod fishery has since 2000 resulted in a continuous reduction in the number of long liners participating in the fishery. Even though the number of vessels has decreased, the total effort does not seem to have been reduced. The number of days each vessel is in the fishery has increased and the total number of weeks the fleet is in the fishery has been nearly constant since 2000. The number of hooks used per vessel per day has increased every year. This together with the

increased time in the fishery has compensated for the reduction of vessels in the fleet and hence there is little or no reduction in the total effort.

During the period 1998 through 2003 the total catch declined from 32675 to 19000 tons while the catch per vessel was relatively stable. The data from 2004-2006 showed that the total catch has been relatively stable with a sharp increase in total catches during 2007 and 2008. The average catch-per-vessel has increased considerably every year since 2004. Current landings are higher than levels recommended by ICES in 2008. It is unlikely that measures implemented in the last 4-5 years has reduced fishing effort to the 1998-level as recommended by ICES in 2004.

It is recognised that caution must be exerted when using CPUE from long liners to study variation in abundance. The data presented here show clearly that the selection of the effort measure is critical. Comparatively crude measures such as “number of fishing days” would not reflect effort in this fishery correctly, and are inferior to “hooks-per-day” series, which appears to be a much preferred measure of effort. “Hooks per day” is in essence a rather readily available measure based on compulsory logbook information. Not accounted for in the 2000-2007 data were changes in efficiency, e.g., by technological advances such as hook design, bait characteristics, effects of fishing practice, e.g., soak times etc., but in the recent period, technological changes appear to have been minor.

## References

- Bergstad, O. A. and Hareide, N.-R. 1996. Ling, blue ling and tusk of the North-East Atlantic. *Fisken og havet* nr. 15.126pp.
- Helle, K., Pennington, M. and Bergstad, O. A. 2006. Tracking the changes in the length composition of ling, blue ling and tusk in commercial catches. Working Document to the ICES Working Group on The Biology and Assessment of Deep-Sea Fisheries Resources. 13 pp.
- Knutsen, H., P. E. Jorde, H. Sannæs, A. R. Hoelzel, O. A. Bergstad, N. C Stenseth. Population structure of tusk (*Brosme brosme*), as revealed from microsatellite DNA analysis. Working Document to the ICES Working Group on The Biology and Assessment of Deep-Sea Fisheries Resources. 21 pp.
- Magnusson, J. V., Bergstad, O. A., Hareide, N.-R., Magnusson, J., Reinert, J. 1997. Ling, blue ling and Tusk of the Northeast Atlantic. Nordic Council of Ministers, TemaNord 1997:535, 64 pp.

Table 1. Summary statistics for the Norwegian long liner fleet during the period 1995-2009 (vessels exceeding 21m).

Year	Number of long liners	Total landed catch by fleet	Average catch per vessel
1995	65	26571	409
1996	66	28645	434
1997	65	20173	310
1998	67	32675	488
1999	71	31528	444
2000	72	28391	394
2001	65	23681	364
2002	58	24619	424
2003	52	18969	365
2004	43	17815	414
2005	39	19106	490
2006	35	19475	556
2007	38	23060	607
2008	36	25069	696
2009	34	21158	622

Table 2. Average number of days that each Norwegian long liner operated in an ICES subarea/division.

All species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
I	9	5	10	12	20	23	11	15	7	16
IIa	54	64	74	73	75	81	73	101	90	87
IIb	2	9	2	3	11	14	3	21	18	4
IIIa	+			1					1	2
IVa	24	22	29	21	22	25	38	27	26	58
IVb	2			1				3		1
Va		1		3	2	2	3	2	4	
Vb	13	18	20	25	34	21	11	15	11	
VIa	12	14	12	12	14	25	13	10	10	6
VIb	10	6	8	6	5	8	7	6	2	
VIIc	2	1			1	0,4		1		
XII	+	5	1	3	1					
XIVb	6	3	8	9	9	5			2	5
All areas	131	148	164	169	195	203	159	201	171	179

Tusk	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
I	3	1	5	5	6	5	1	5	4	3
IIa	34	57	66	58	60	69	67	89	92	75
IIb	1		2		1	2	1	3	4	
IVa	18	22	28	19	21	25	37	26	30	56
IVb	1			2						
Va		1		3	2	2	3	2	4	
Vb	11	18	20	25	34	21	11	15	14	
VIa	12	14	12	12	14	23	13	10	15	6
VIb	4	6	8	5	5	8	7	6	5	
VIIc	2	1			1	0		0		
XII	1	3								
XIVb	2	1	2	1	3	3				3
All areas	88	124	141	130	148	158	140	157	169	143

Ling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
IIa	23	40	50	40	37	51	54	65	52	61
IIIa	+			1					1	2
IVa	19	22	29	20	22	25	38	27	25	58
IVb	1	+		1				3		1
Va		1		3	2	2	3	2	4	
Vb	12	17	18	24	34	21	11	15	11	
VIa	13	13	11	12	14	23	13	10	9	6
VIb	4	5	7	4	5	8	7	6	2	
VIIc	3	1			1	+		1		
All areas	76	100	114	104	115	126	126	128	104	127

Blue ling	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
IIa	1	1	1	1	+	+	1	1	2	2
IVa	1	+	1		1	1	2	2	4	6
Va		1		1	2	1	2	1	3	
Vb	4	3	4	5	5	1	4	5	4	
VIa	9	6	4	8	6	10	8	6	10	6
VIb	1	1	2	2	+		+	1		
XII	2	5		2						
XIVb	+		+	+	+	+			1	2
All areas	18	15	11	14	14	14	18	16	25	16



Table 3. Average number of hooks the Norwegian long liner fleet used per day in each of the ICES subareas/divisions and in the total fishery for the years 2000-2007 in the fishery for tusk, ling and blue ling. n is the total number of days with hook information contained in the logbooks.

All	2000		2001		2002		2003		2004		2005		2006		2007		2008		2009	
	Average	n	Average	n	Average	n	Average	n	Average	n	Average	n	Average	n	Average	n	Average	n	Average	n
<b>I</b>	31688	353	33325	163	35432	263	35045	376	32431	433	32671	316	33182	187	34380	318	36833	96	40018	113
<b>IIa</b>	31439	1916	30703	2196	33431	2031	34766	1839	33475	1389	32861	1248	35140	1252	35207	2103	36890	1500	37727	604
<b>IIb</b>	35409	71	34638	315	34756	45	34776	67	31859	217	35082	207	39298	57	37881	328	39650	297	41300	30
<b>IIIa</b>	30250	4					33037	27							35000	8	36467	15	34636	11
<b>IVa</b>	29378	685	30553	727	32291	667	33484	510	30934	439	34039	331	34561	673	33414	587	34056	395	36651	402
<b>IVb</b>	30263	38	33500	10	33867	15	32559	34							38086	58	31500	10	30167	6
<b>Va</b>							22605	38	25815	54	23100	30	21526	57	25414	58	32704	71		
<b>Vb</b>	24594	411	26760	613	25939	475	29513	515	31804	693	29885	374	27943	159	30681	355	27968	188		
<b>VIa</b>	22763	435	24419	447	21484	186	29421	302	25636	308	24807	369	22504	248	25958	249	26319	138	21725	40
<b>VIb</b>	30471	227	30340	140	31557	149	31325	97	31559	111	35949	137	32273	139	36400	145	33514	35		
<b>VIIc</b>	29600	80	33108	37					25250	28	33429	7			31071	14				
<b>XII</b>	18136	22	17548	175			13063	48												
<b>XIVa</b>	28333	6																		
<b>XIVb</b>	2815	191	2465	135	9458	251	11515	228	12474	105	18960	91					9464	45	7034	38
<b>All areas</b>	28325	4429	28743	4958	30432	4083	31794	4081	31285	3777	31438	3110	32959	2711	34110	4223	35042	2790	36157	1244

Table 4. Estimated total number of hooks (in thousands) the Norwegian long liner fleet used in each of the ICES subareas/divisions and in the total fishery for the years 2000-2007 in the fishery for tusk, ling and blue ling.

<b>All</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
<b>I</b>	20534	10831	20551	21868	27891	29306	12775,07	19081	9282	21770
<b>IIa</b>	117708	127724	143486	131972	107957	103808	89783	131569	119524	111596
<b>IIb</b>	5099	20263	4032	5425	15069	19155	4126	29434	25693	5617
<b>IIIa</b>	218			1718				0	1313	2355
<b>IVa</b>	50765	43691	54313	36565	29264	33188	45966	33381	31876	72276
<b>IVb</b>	4358			1693				4228		1026
<b>Va</b>	0			3526	2220	1802	2260	1881	4709	
<b>Vb</b>	23020	31309	30089	38367	46497	24476	10758	17028	11075	
<b>VIa</b>	19667	22221	14953	18359	15433	24187	10239	9604	9475	4432
<b>VIb</b>	21939	11833	14642	9773	6785	11216	7907	8081	2413	
<b>VIIc</b>	4262	2152			1086	521		1150	0	
<b>XII</b>	1306	5703		2038				0	0	
<b>XIVb</b>	1216	481	4389	5389	4827	3697		0	681	1196
<b>All areas</b>	<b>267161</b>	<b>276508</b>	<b>289469</b>	<b>279406</b>	<b>262325</b>	<b>248895</b>	<b>183567</b>	<b>253676</b>	<b>215719</b>	<b>220052</b>

Table 5. Estimated mean CPUE ([kg/hook] x1000) based on log book data along with its standard error (*se*) and number of catches sampled for tusk, ling and blue ling.

Tusk																														
	2000			2001			2002			2003			2004			2005			2006			2007			2008			2009		
Area	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se
I	21,6	189	2,1	18,8	53	3,2	4,2	115	2,0	11,9	141	1,7	3,8	122	2,2	3,5	73	3,7	7,8	18	9,5	7,95	108	2,7	6,78	32	6,38	1,58	23	7,95
IIA	59,5	1678	0,7	52,5	1959	0,5	47	1809	0,5	40,1	1473	0,5	36,1	1096	0,8	49,5	1060	1,0	56,3	1145	1,2	53,1	1853	0,7	57,5	1247	1,03	66,6	518	1,68
IIB	4,1	8	10,4	10,8	17	5,6				5,3	5	9,0	2,2	20	5,6	2,7	12	9,2	5,62	6	16,4	2,85	19	6,4	8,02	68	4,42			
IVA	35,7	664	1,2	32,6	721	0,8	25	649	0,9	29,8	496	0,9	49,3	437	1,2	36,4	329	1,8	44,6	664	1,6	51,2	583	1,2	59,4	395	1,83	31,2	389	1,93
IVB	18,1	17	7,2	16,5	2	12,4				7,22	13	5,6																		
VA										105	38	3,3	165	54	3,4	184	30	5,8	194	57	5,3	155	58	3,7	131	69	4,39			
VB	56,8	405	1,5	50,2	608	1,0	50,1	473	1,0	53,7	514	0,9	59,3	693	0,9	66,5	374	1,7	98,9	159	3,2	64,7	353	1,5	78,9	188	2,66			
VIA	48	430	1,4	40,7	444	1,1	45,9	186	1,6	36,1	300	1,2	50,3	307	1,4	59,1	368	2,7	106	247	2,6	66,1	249	2,4	126	137	3,11	142	40	6,02
VIB	76,8	222	2,0	50,6	132	2,0	55,2	149	1,7	44,9	94	2,1	62,7	111	2,4	72,5	136	2,7	41,2	138	3,4	26,1	135	2,4	29,6	35	6,16			
VIIC	62,7	60	3,8	4,8	25	4,6							7,05	23	5,2	15,9	7	12,0				5,14	10	8,8						
X																														
XII	47,2	17	7,2	28,2	97	2,3				6,47	7	7,6																		
XIVA	74,6	6	12,0																											
XIVB	40,9	84	3,2	48,5	48	3,3	85,1	70	2,6	49,7	42	3,1	17,9	60	3,2	8,7	47								59,3	34	6,25	70,4	20	8,52

Ling																														
	2000			2001			2002			2003			2004			2005			2006			2007			2008			2009		
Area	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se
I										1,7	3	12,7																		
IIA	23,9	1064	0,7	21,9	1352	0,6	24,2	1345	0,5	29,1	925	0,7	37,3	630	0,9	49,8	775	1,1	42,3	928	0,9	40	1334	0,6	47,6	859	0,93	58,8	426	1,68
IIIA	4,53	3	13,3							2,4	25	4,4									6,52	8	7,7	7,39	15	7,02	7,37	11	10,4	
IVA	56,5	669	0,9	48,1	729	0,8	55,5	618	0,7	57,2	505	1,0	78,5	439	1,1	85,1	328	1,7	92,5	672	1,0	76,6	586	0,9	83,8	391	1,37	98,7	402	1,73
IVB	8,3	25	4,6	2,4	12	6,0	1,4	3	11,0	2,9	29	4,1									5,18	56	2,9	3,91	9	9,06	7,61	6	14,1	
VA										70,6	38	3,6	46,6	54	3,2	38,8	29	5,7	68,4	56	3,5	84,6	58	2,9	83	69	3,27			
VB	71,9	399	1,2	62,6	595	0,8	65,6	466	0,9	71,3	501	1,0	71,7	693	0,9	82	373	1,6	84,3	157	2,1	77,5	349	1,2	95	186	1,99			
VIA	101	421	1,1	85,9	424	1,0	77,8	177	1,4	76,4	296	1,3	102	308	1,3	117	369	1,6	94,5	248	1,7	107	248	1,4	72,4	131	2,38	98,4	40	5,48
VIB	45,4	211	1,6	33,5	127	1,8	37,6	149	2,2	67,9	85	2,4	71,9	110	2,3	68,8	137	2,6	90,4	138	2,2	89,2	145	1,8	147	35	4,6			
VIIC	82,9	78	2,6	78,4	37	3,4			0,0							122	28	4,5	66,4	7	11,6									
XIVA	3,75	6	9,4																						23,3	1				

**Blue ling**

	2000			2001			2002			2003			2004			2005			2006			2007			2008			2009			
Area	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	
IIA	12	14	3,8	7,89	14	10,2	3,1	5	3,5	4,9	6	7,7				3,2	3	4,3	3,87	17	2,9	4,14	20	6,0	4,32	9	3,59	1,11	13	4,62	
IVA	6,79	10	4,7	5,5	8	13,5	6,2	14	2,1	8,3	14	5,1	3,3	23	2,2				5,1	47	1,7	5,31	36	4,5	7,5	76	1,24	15,3	45	2,49	
VA										7,3	9	6,3	26,8	49	1,5	15,1	21	1,6	16,1	42	1,8	4,1	16	6,7	11,3	61	1,37				
VB	8,1	44	2,2	11,3	84	4,2	8	65	1,0	25,4	68	2,3	8,6	70	1,2	10,4	20	1,7	20,5	57	1,6	53,5	78	3,0	16,9	69	1,29				
VIA	8,28	107	1,4	4,5	140	3,2	8,9	46	1,1	7,4	125	1,7	7,7	110	1,0	7,6	162	0,6	13,6	156	0,9	7,53	86	2,9	14,8	170	0,82	15,3	40	2,64	
VIB	61,3	8	5,0	16,9	11	11,5	2,6	13	2,1	113	12	5,5							1,93	6	4,8	1,81	15	6,9	3,65	6	4,39				
XII	213	17	3,5	137	123	3,5				25,1	36	3,1																			
XIVB							4,8	3	4,5				14,7	5	4,7								40,6	12	3,1	64,3	14	4,46			

Table 6. Estimated mean CPUE ([kg/hook]x1000) based on data from the reference fleet, along with its standard error (*se*) and number of catches sampled for tusk, ling and blue ling.

Tusk	2001			2002			2003			2004			2005			2006			2007		
Area	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se
I				2,1	43	6,35	1,13	77	3,26	2,39	44	4,96	1,83	51	5,44	4,41	60	7	24,7	16	10,7
IIA	22,1	46	3,6	41,4	208	2,89	35,1	296	1,66	32,6	431	1,58	63,4	349	2,09	61,8	498	2,43	75,1	447	2,03
IIB										8,74	2	23,3	0,55	4	19,4	4,69	45	8,08	3,06	68	5,21
IVA							73,7	40	4,52	13,7	83	3,61	21,8	99	3,9	37,5	90	5,72	10,7	59	5,6
VA										105	32	5,81							156	24	8,77
VB							60,1	12	8,25	71,6	71	3,9	57,3	84	4,24	80,8	54	7,38	61,1	71	5,1
VIA							13,1	45	4,26										33,2	22	9,16
VIB				36,7	29	7,34	31,2	61	3,66							34	26	10,6	9,71	22	9,16
XII							2,11	6	11,7												
XIVB										13,6	5	14,7	10,1	14	10,4						

Ling	2001			2002			2003			2004			2005			2006			2007		
Area	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se
IIA	9,4	19	2,17	27	88	2,08	33	134	2,03	47,1	183	2,46	54,4	275	2,4	54,9	366	2,33	52,7	402	1,61
IVA							31,1	40	3,71	99,8	83	3,66	82,6	99	4	78,2	90	4,71	81,9	59	4,2
VA										72,5	32	5,89							81,2	24	6,58
VB							59,1	12	6,77	51	69	4,01	74,4	85	4,3	82,9	54	6,08	60,1	71	3,83
VIA							83,3	43	3,58										87,1	22	6,88
VIB				59,4	5	8,71	31,1	34	4,02							114	32	7,9	113	24	6,58

Blue ling	2001			2002			2003			2004			2005			2006			2007		
Area	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se	CPUE	n	se
IIA										0,51	3	12,8	2,82	10	0,84	5,78	5	1,74			
IVA													1,64	2	1,89	4,74	6	1,59			
VA										20,4	24	4,51							3,68	16	1,09
VB										14	10	7	2,11	25	0,53	1,37		1,23			
VIA							7,7	5	18,4										7,28	15	1,12
VIB				117	32	9,53	85,2	43	6,27										0,7	7	1,64
XII							36,7	21	8,97												
XIVB										3,31	2	15,6	4,5	8	0,94						

Table 7. Estimated mean length of ling in the period 1996-1995 are from Bergstad and Hareide (1996). The 2001-2007 estimates along with their standard errors (se) based on the reference fleet data, N denotes the number of fish measured and in parenthesis is the number of stations sampled. The unweighted mean was calculated for 2001, 2002 and areas V and VIb in 2003 and the weighted mean for the other years and areas.

Ling ICES-		1976	1988	1989	1990	1991	1993	1994	1995		2001	2002	2003	2004	2005	2006	2007
IIa	Mean			81,7	89,4	91,1	79,5	77,1		Mean	90,78	88,81	80,42	86,19	86,73	87,34	86,7
	Std,dev			15,2	13,5	13,5	13,7	12,3	8,3	se		1,6	0,55	1,05	0,42	0,11	0,09
	N			61	384	63	122	304	382	N	485 (13)	4793 (72)	4620 (102)	4139 (102)	11693 (216)	17764	21907
IVa	Mean	87	81,1	76,8	81,1		74,6	77	81,1	Mean			79,14	88,9	88,88	90,38	89,64
	Std,dev	13,8	14,4	12,5	12,3		14,5	10,8	13	se			0,9	0,65	0,68	0,021	0,23
	N	1133	989	487	698		589	830	2203	N			1702 (38)	4654 (80)	5109 (55)	5124	3477
Va	Mean									Mean				83,47			81,6
	Std,dev									se				0,81			0,39
	N									N				1502(29)			1238
Vb1	Mean			80			76,7			Mean			78,49	81,36	85,28	84,67	84,77
	Std,dev			13,7			12,1			se			1,84	2,66	0,5	0,028	0,22
	N			45			107			N			446 (9)	290 (12)	4130 (80)	2734	3919
Vb2	Mean	90,3		82,7	85					Mean							
	Std,dev	13,8		12	13,7					se							
	N	253		614	318					N							
VIa	Mean	80		79,1			71,9	72	73,7	Mean		79,3	79,17				78,95
	Std,dev	11,5		13,5			10,6	10,5	10	se			0,86				0,39
	N	492		969			472	616	583	N		160 (2)	2590 (41)				1265
VIb	Mean	89,7		72,5	77,7		79,8	92	88,3	Mean		102,3	89,54			92,59	88,42
	Std,dev	9,8		16,7	13,6		12,4	16,2	12,2	se			1,1			0,28	0,33
	N	507		518	261		47	401	48	N		367 (5)	1393 (25)			2734	1680
All areas	Mean	86,5	81,1	78,4	83,3	91,2	74,5	78,4	81,1		91,49	89,48	81,71	87,49	87,76	88,15	86,37
	Std,dev	13	14,4	14,2	13,7	13,6	13,1	13,9	13								
	N	2385	989	2694	1661	63	1337	2152	3220		570	5325	10912	10585	20934	28572	33557

Table 8. Estimated mean length of tusk in the period 1996-1995 are from Bergstad and Hareide (1996). The 2001-2007 estimates along with their standard errors (se) based on the reference fleet data, N denotes the number of fish measured and in parenthesis is the number of stations sampled. The unweighted mean was calculated for 2001, 2002 and areas V and VIb in 2003 and the weighted mean for the other years and areas.

Tusk		The unweighted mean was calculated for 1981, 1982 and areas I and II in 1983 and the weighted mean for the other years and areas.															
ICES-area,		1976	1988	1989	1990	1991	1993	1994	1995		2001	2002	2003	2004	2005	2006	2007
I	I								Mean			50,89	57,45	59,89	57,54	57,36	55,7
									se			0,61	1,23	0,86	1,1	0,28	0,35
									N			193 (2)	365 (25)	592 (33)	495(28)	870	545
IIa	I		63,14	50,8	55,39	54,81	50,72	49,78	49,51	Mean	52,68	53,08	49,76	52,56	51,02	51,47	50,26
										se	3,9	0,4	0,39	0,29	0,24	0,05	0,05
			14	1231	1273	865	1374	1837	377	N	4145 (30)	13183(5)	13321 (174)	11986 (278)	15759(268)	25344	27509
IIb									Mean							56,46	54,1
									se							0,23	0,24
									N							1217	1166
IVa	I	60,53	49,89	52,69	53,45		46,8	49,87	54,62	Mean			49,45	50,14	51,79	52,43	50,39
										se			0,7	0,67	0,84	0,13	0,17
										N			2465 (22)	3394(80)	3233 (63)	3834	2285
Va	I	377	976	1329	636		336	1379	1209	Mean				57,68			55,29
										se				0,57			0,21
										N				1832 (30)			1440
Vb1	I	65,44		57,55		54,23	48,24	52,07		Mean		65,41	54,25	51	49,42	49,58	49,46
										se		0,42	1,96	1	0,31	0,15	0,13
										N		392 (5)	559(10)	1064 (18)	4916 (82)	3068	4189
Vb2	I	63,76		55,78	56,64					Mean							
										se							
										N							
VIa	I	142		470	852												
	I	65,08		57	60,34		54,18	53,67	54,39	Mean			51,74				56,03
										se			0,78				0,23
										N			938(39)				1224
VIb	I	150		385	973		190	206	72	Mean							
	I	67,28		53,33			49,02	54,96		se		61,42	64,27		56,93	59,84	65,64
										N		0,17	0,87		2,42	0,21	0,24
												2365 (11)	2484(49)		180 (3)	3068	1175
All areas	I	853		945			341	916									
	I	65,62	50,08	53,12	56,64	54,73	49,84	51,13	53,45	Mean	52,68	54,58	51,84	53,33	51,38	52,07	51,19
	I	2148	990	4476	3734	1004	2707	4539	1658		4145	16134	20196	18929	24601	35874	39533

Table 9. Unweighted estimates of the mean length of blue ling during 2003-2005, along with its standard error (se) and number of fish measured,

<b>Blue ling ICES- area</b>		<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
IIa	Mean	89,44	77,46	91,91	79,5	65,04
	se	1,52	3,73	1,9	1,7	1,98
	N	61	13	56	146	22
IVa	Mean			54,19	74,9	74
	se			3,56	4,5	
	N			16	20	1
Va	Mean		58,72			
	se		0,62			
	N		460			
Vb	Mean		96,35	107,79	104,5	109,25
	se		1,32	3,81	5,2	3,29
	N		103	14	15	8
VIa	Mean	83,6				91,49
	se	1,88				0,57
	N	40				263
VIb	Mean	91,26				96,86
	se	0,16				1,55
	N	5743				36
XII	Mean	91,07				
	se	0,56				
	N	445				
All areas	Mean	91,18	87,434	87,48	81,33	90,69
	N	6290	576	86	184	330



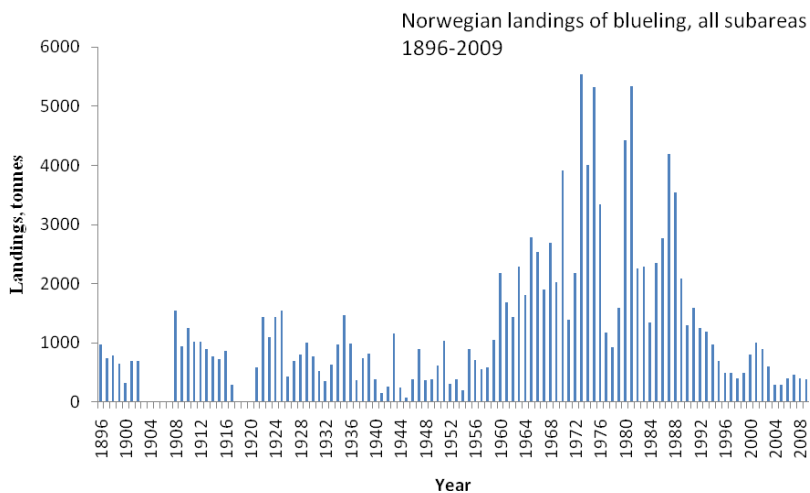
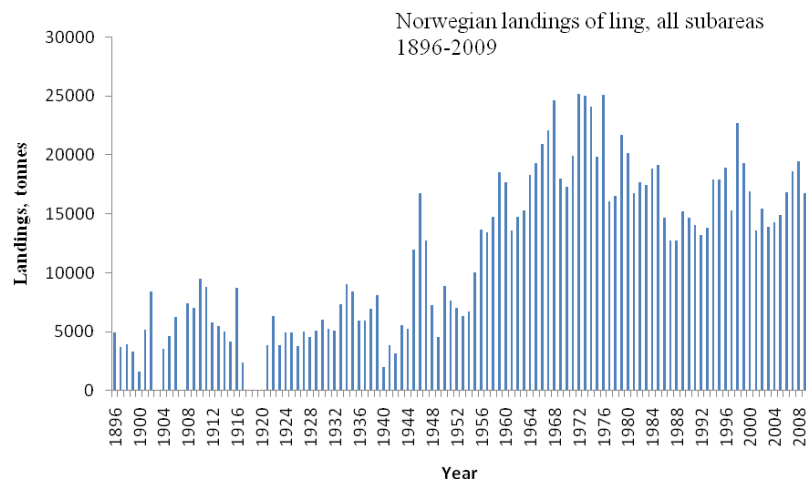
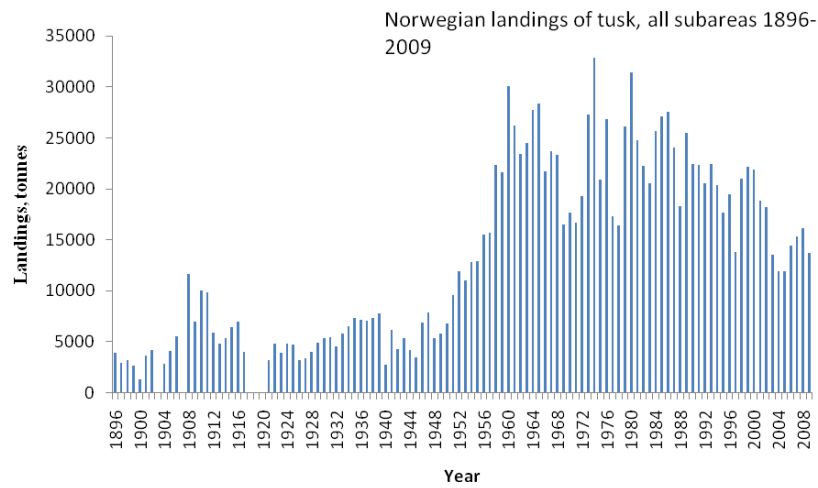


Figure 1. Reported Norwegian landings of tusk, ling and blue ling for the period 1896 -2009.

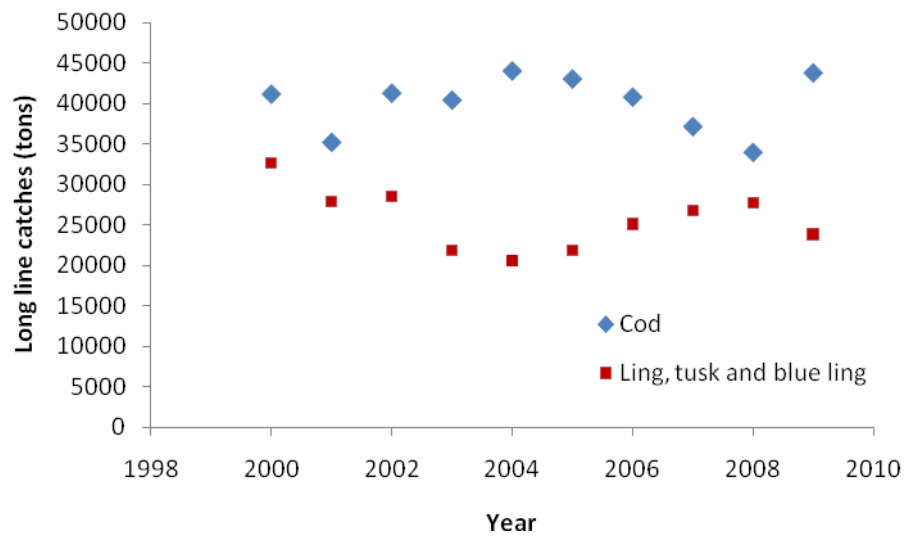
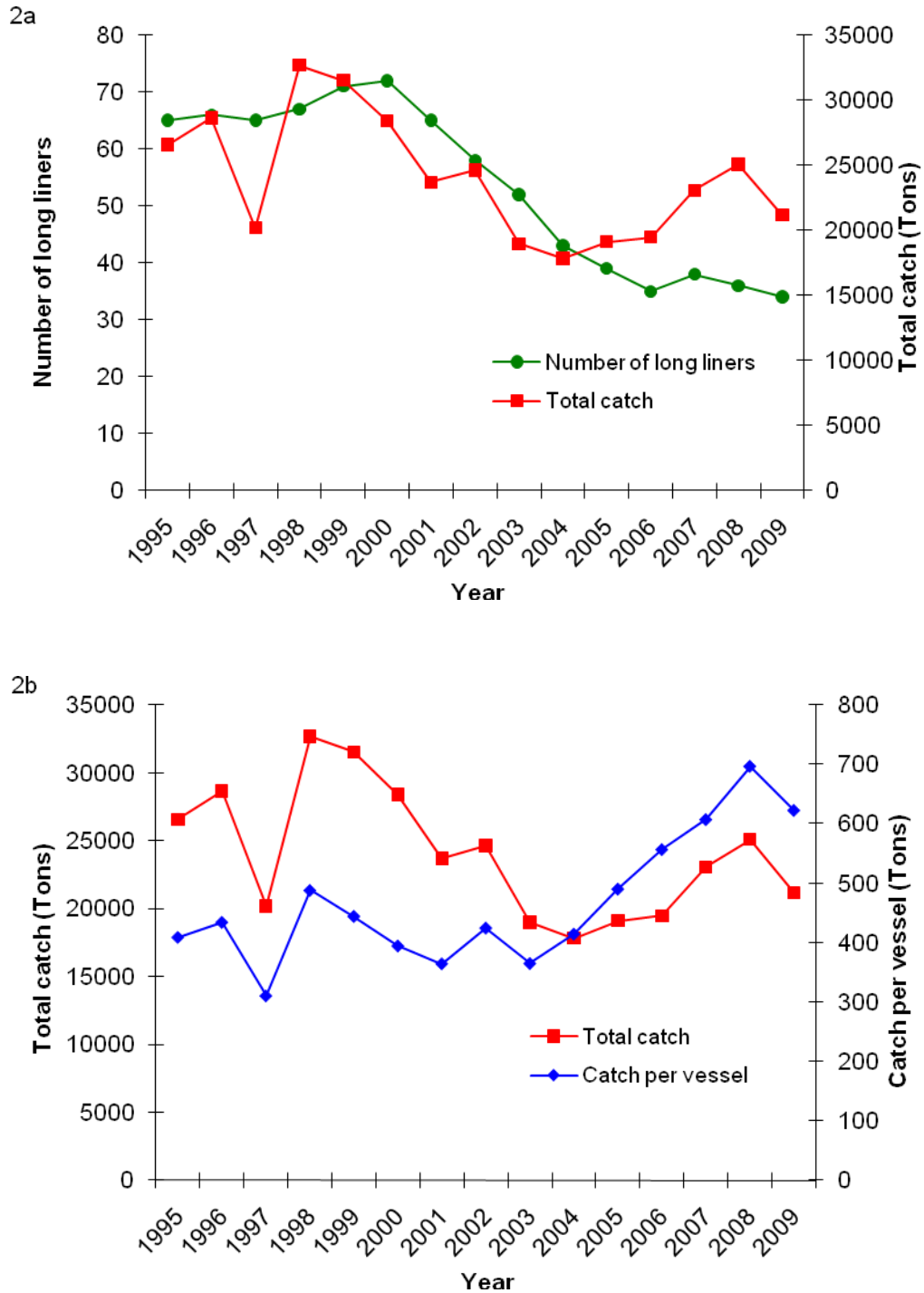


Figure 2. Total catch by the longliners of cod and ling, tusk and blue ling combined.



**Figure 2.** The long liner fleet and landings of ling and tusk in the period 1995-2009. a) The number of long liners and the total reported catch, b) the total catch and the catch-per-vessel.

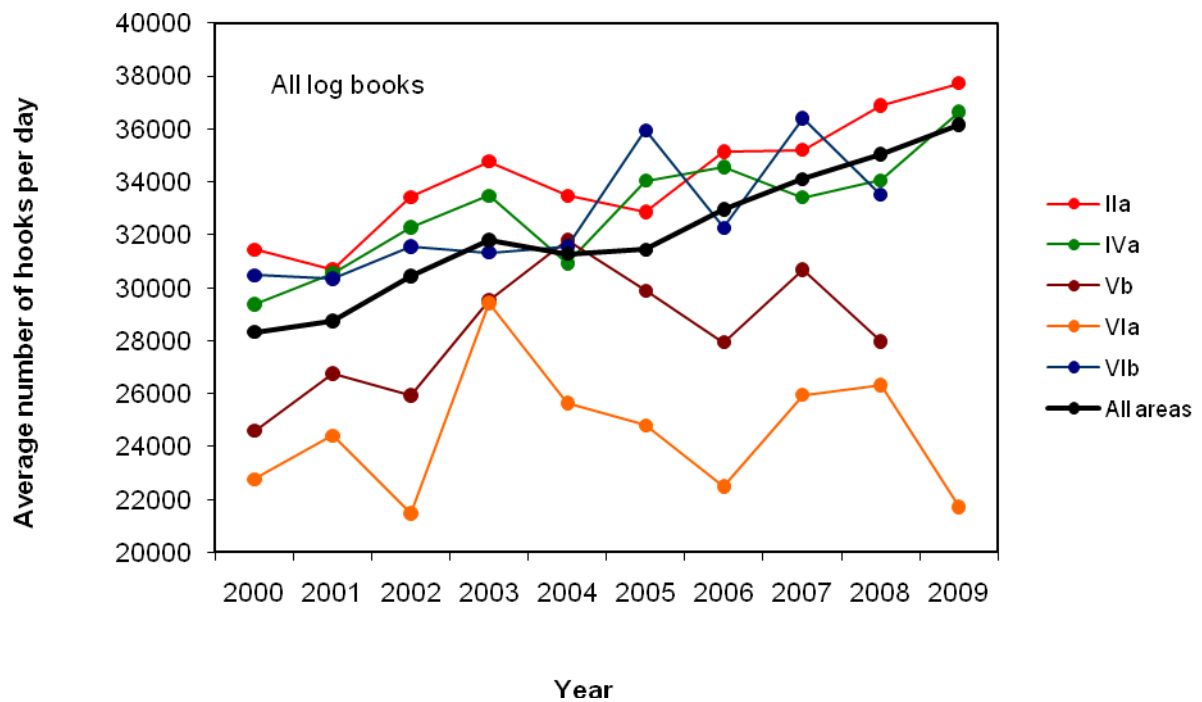


Figure 3. Average number of hooks the Norwegian long liner fleet used per day in each of the ICES subareas and in the total fishery for the years 2000-2009 in the fishery for tusk, ling and blue ling.

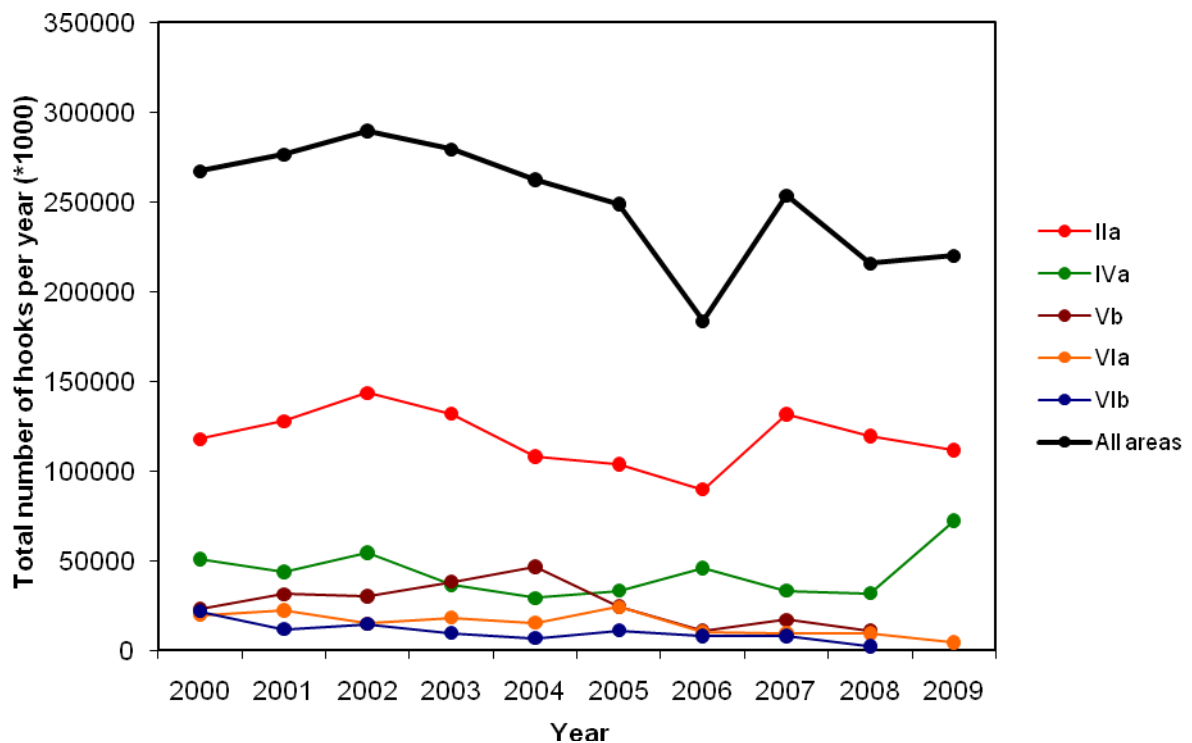


Figure 4. Estimated total number of hooks (in thousands) the Norwegian long liner fleet used in the ICES subareas with highest catches and in the total fishery for the years 2000-2009 in the fishery for tusk, ling and blue ling.

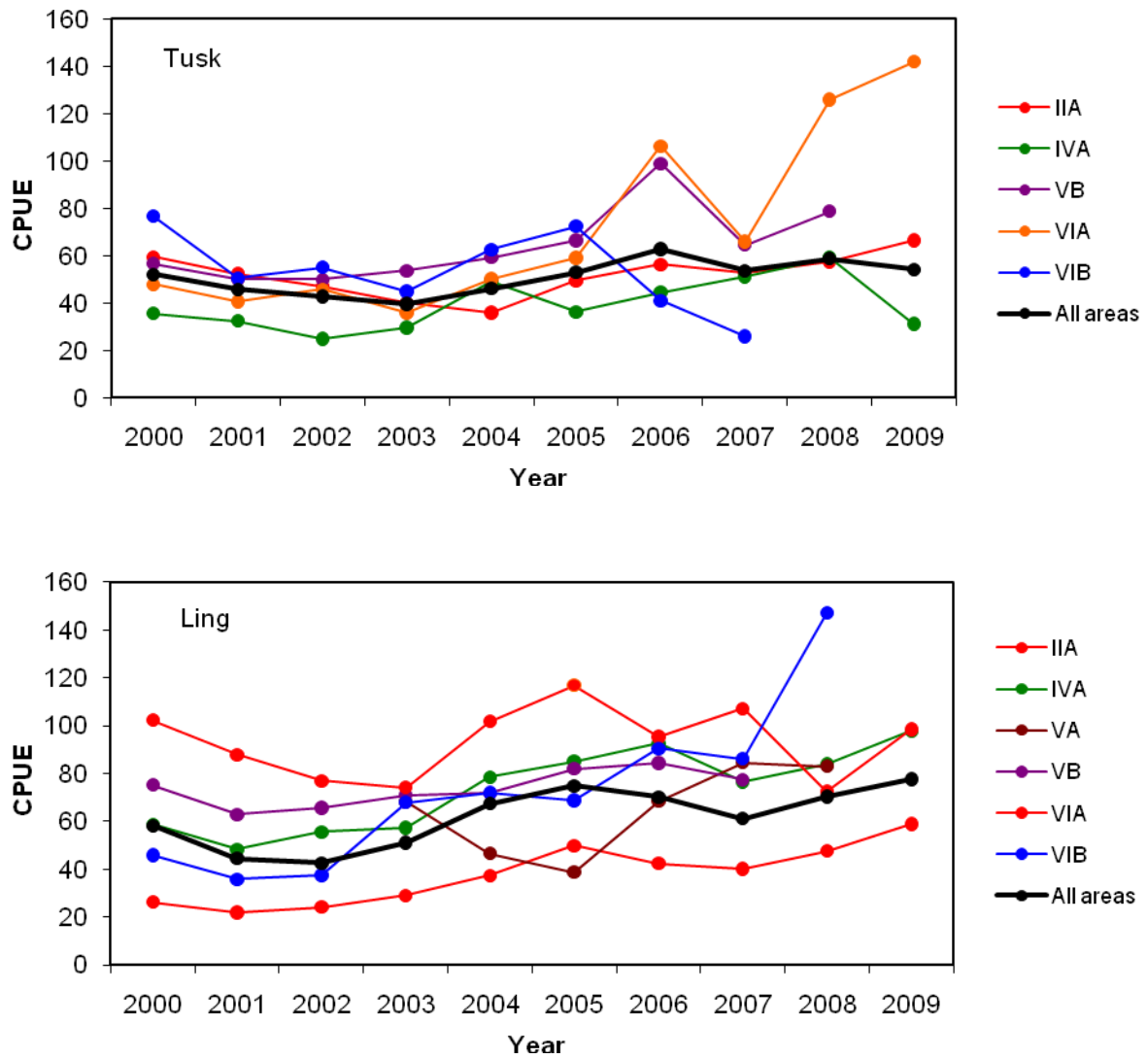


Figure 5. Estimated mean CPUE ([kg/hook]x1000) based on data from the log books for tusk and ling in each ICES subarea and all areas combined for the years 2000- 2009.

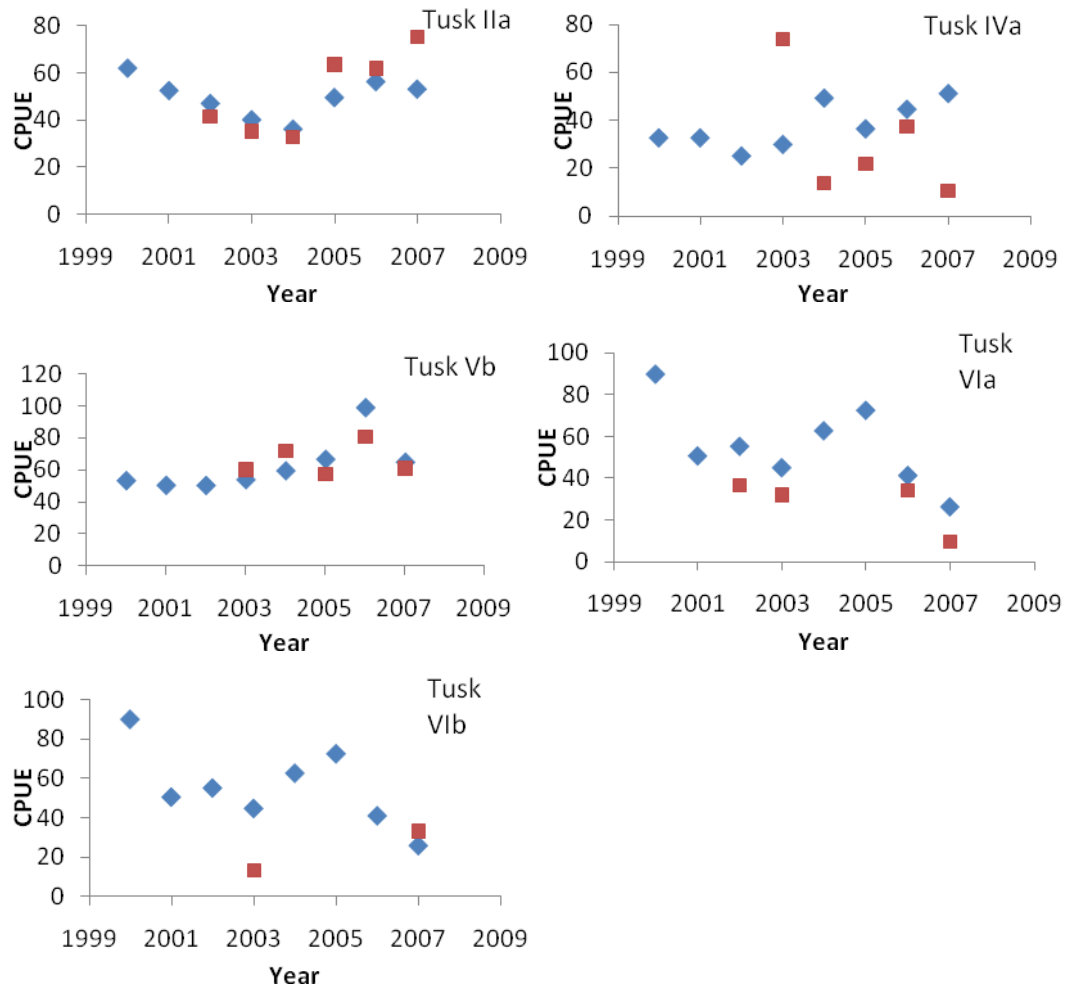


Figure 6. CPUE ([kg/hook] x1000) for tusk Estimated from the logbook data (blue diamonds) and from the reference fleet (red squares) for the sub areas IIa, IVa, Vb, VIa and VIb.

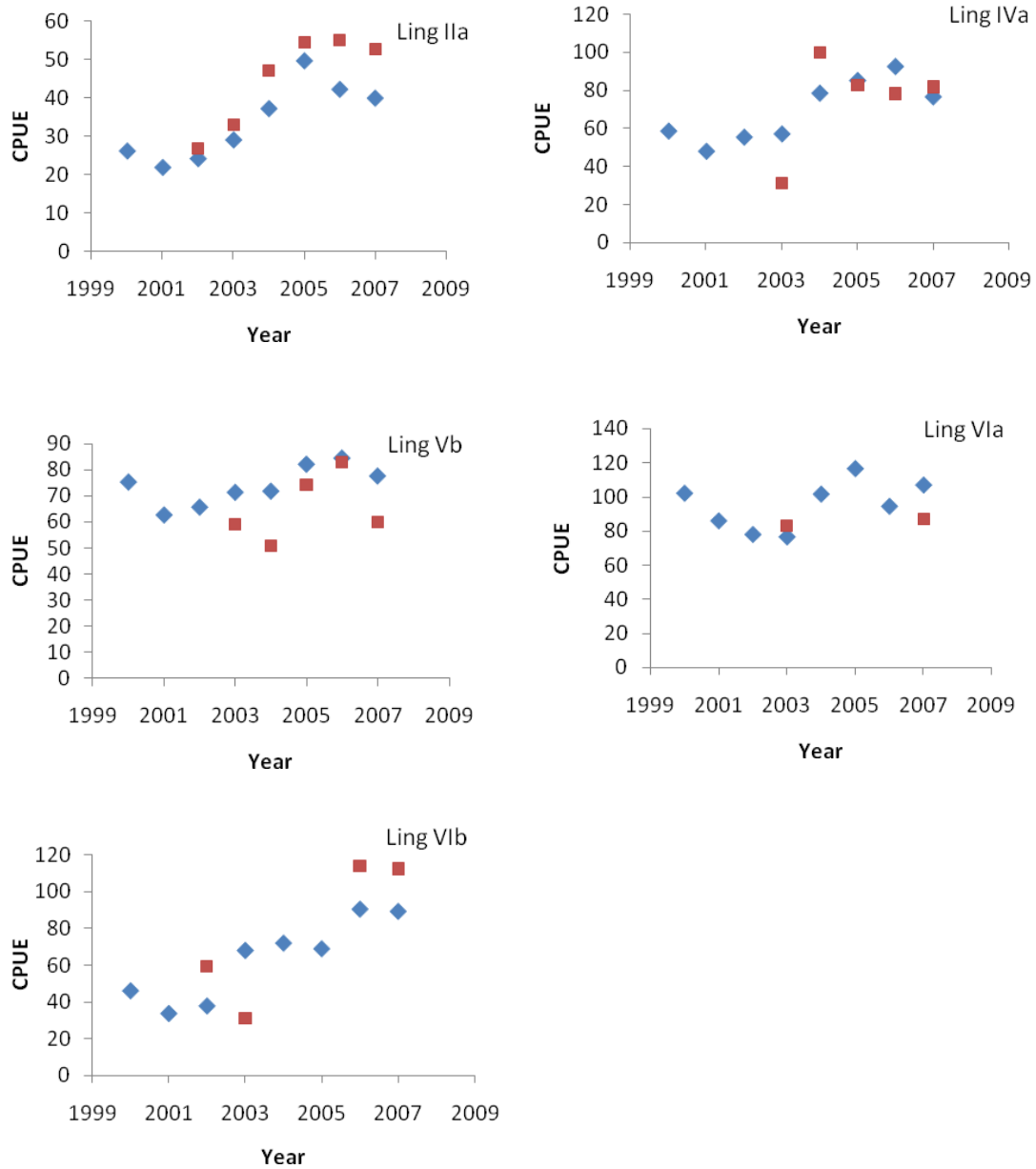
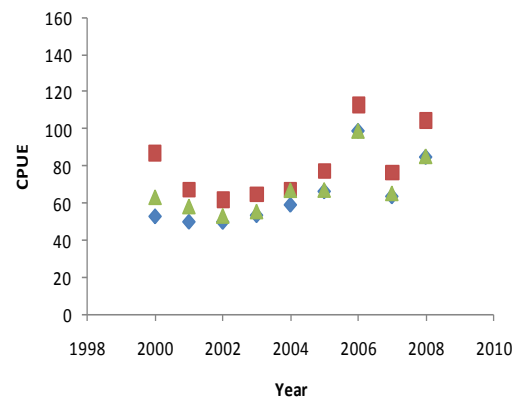
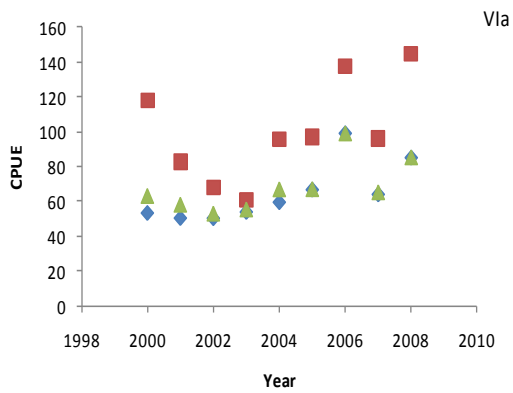
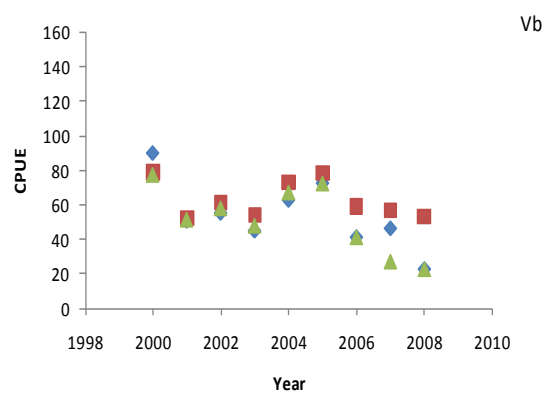
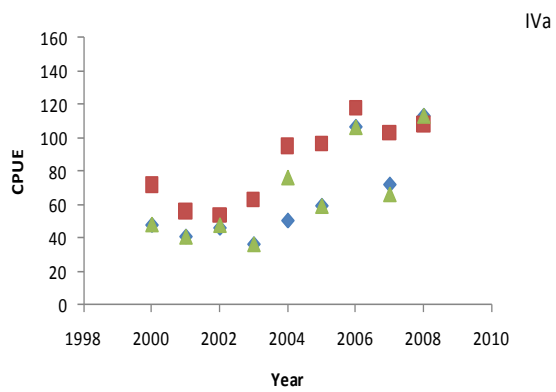
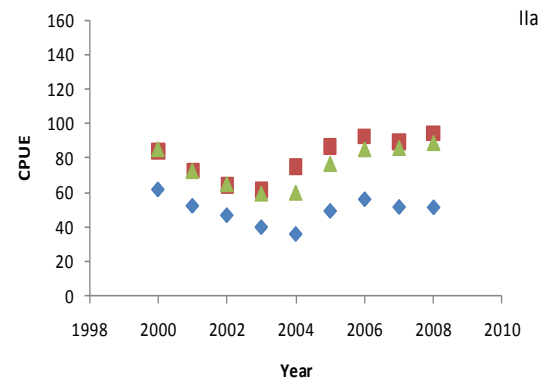
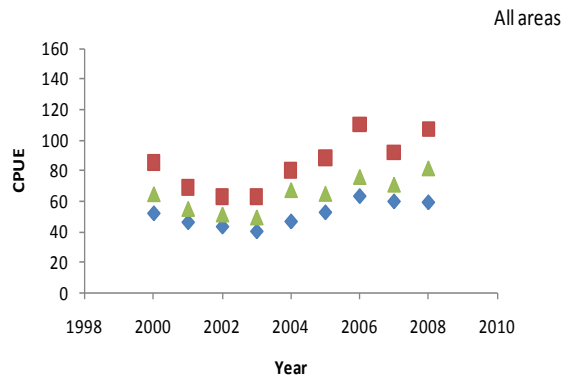
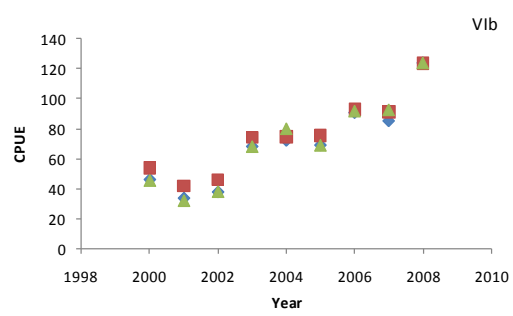
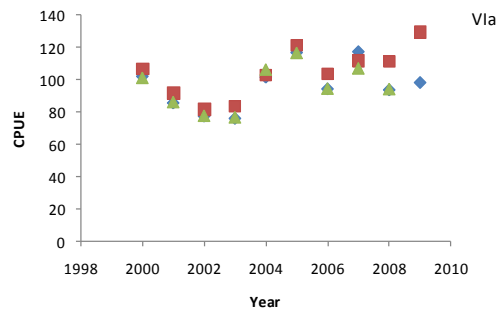
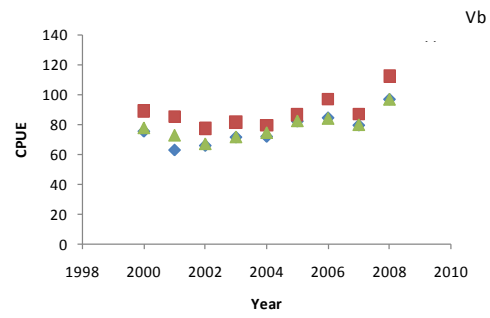
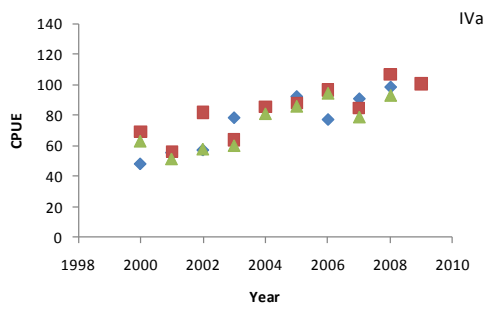
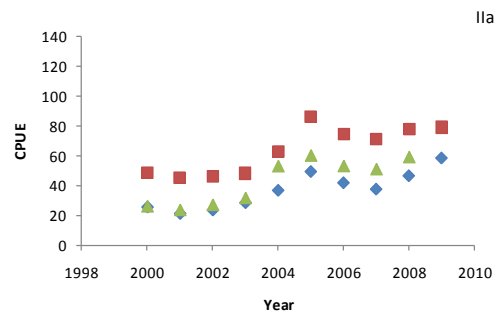
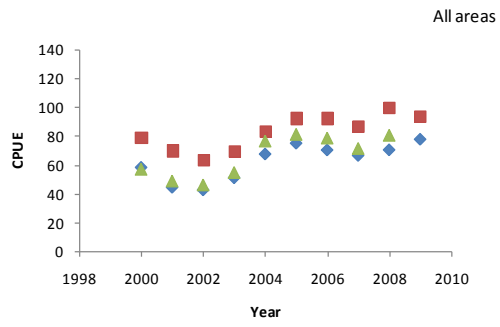


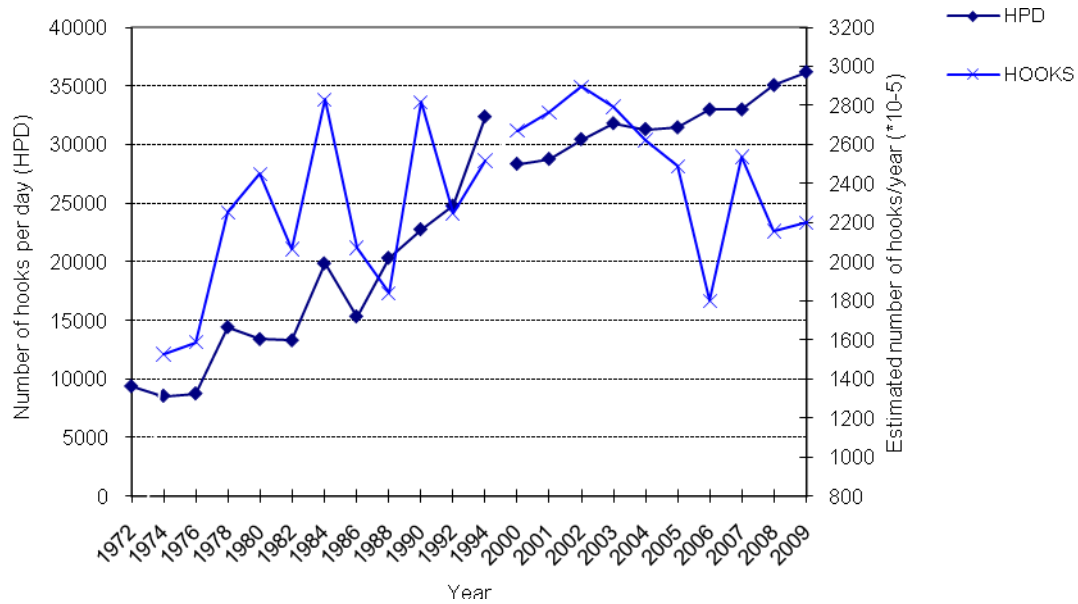
Figure 7. CPUE ([kg/hook] x1000) for ling estimated from the logbook data (blue diamonds) and from the reference fleet (red squares) for the sub areas IIa, IVa, Vb, VIa and VIb.



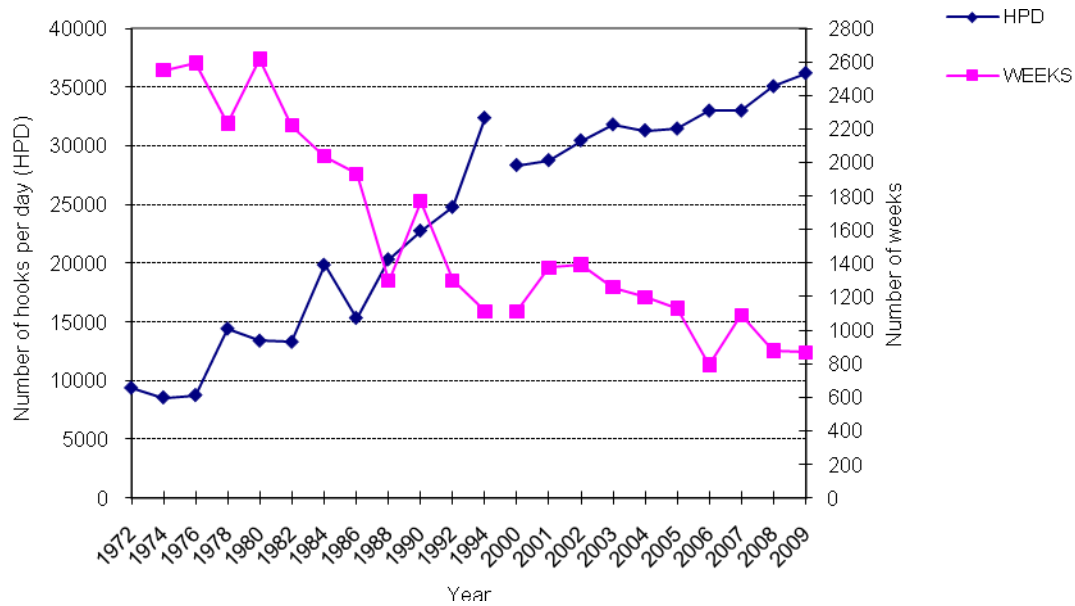




a.



b.



Figur

e 10. Results for the combined time series 1972-1994 from Bergstad and Hareide (1996) and the new data from 2000-2009. a) The numbers of hooks used per day and the total number of hooks used per year. b) The numbers of hooks used per day and the total number of weeks the long liners participated in the fishery for ling and tusk.

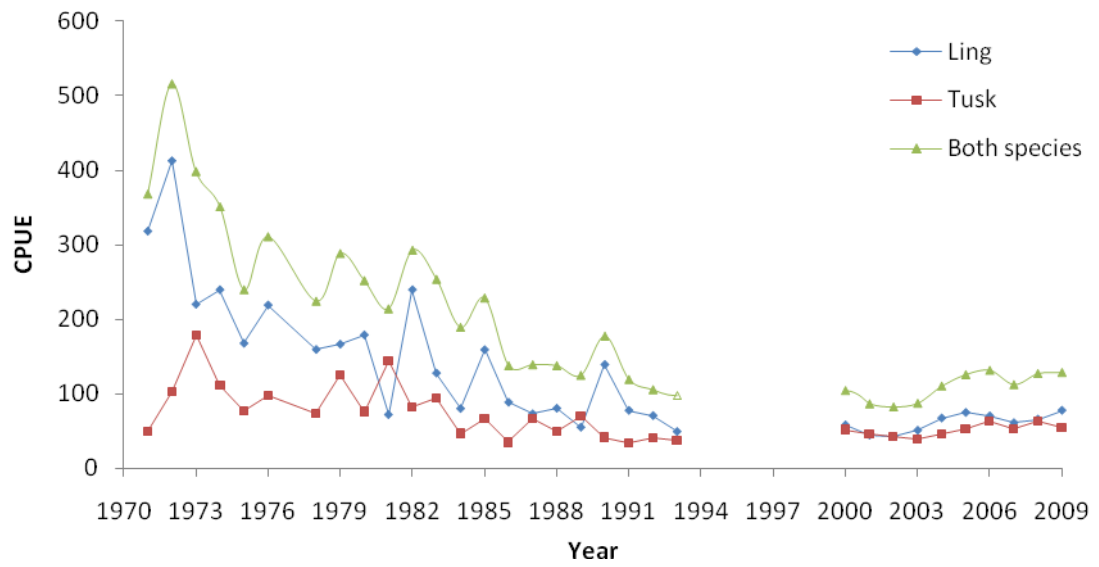


Figure 11. CPUE ([kg/hook] x1000) for ling, tusk and both species combined for the period 1971 through 1993 and for 2000 through 2009.

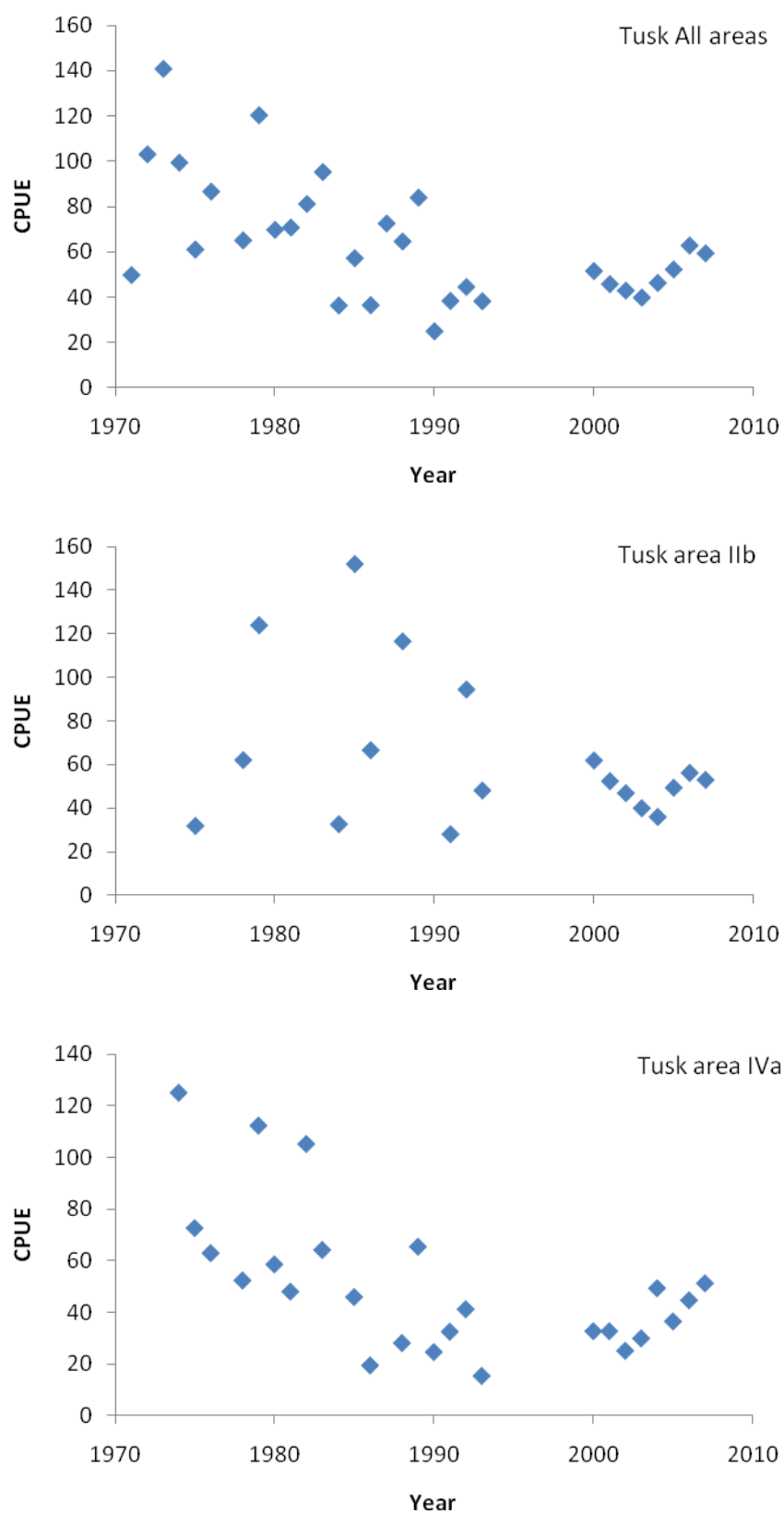


Figure 12. CPUE ([kg/hook] x 1000) for tusk for all the ICES sub areas combined and separate for the sub areas IIa, IVa, Vb, VIa and VIb for the period 1971 through 1993 and for 2000 through 2007.

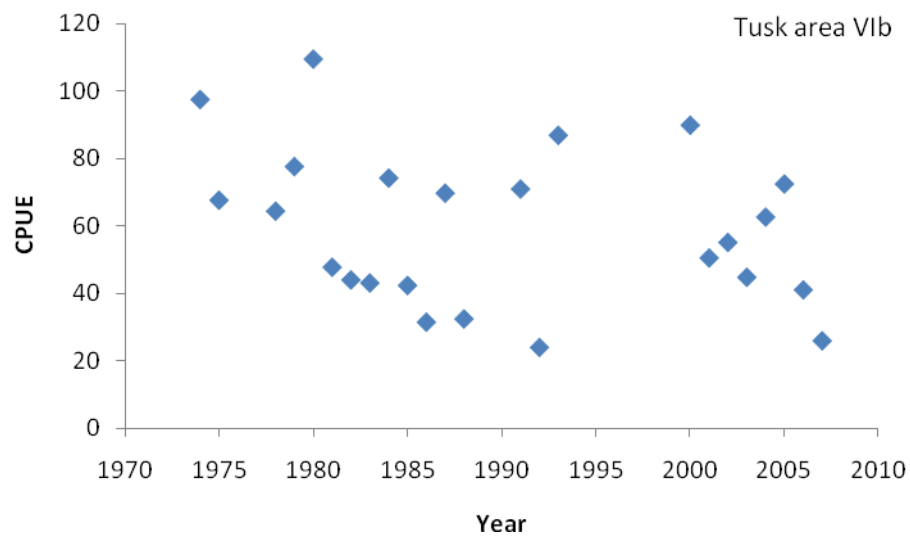
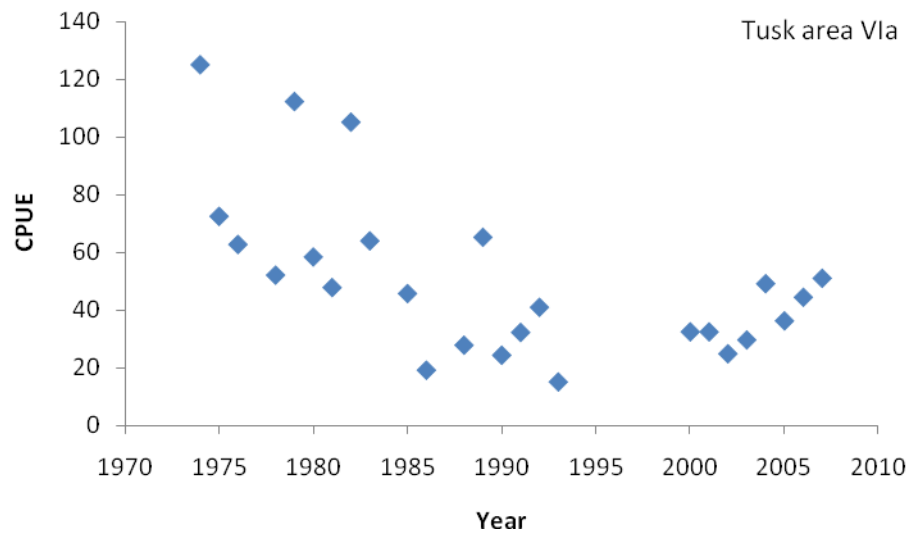
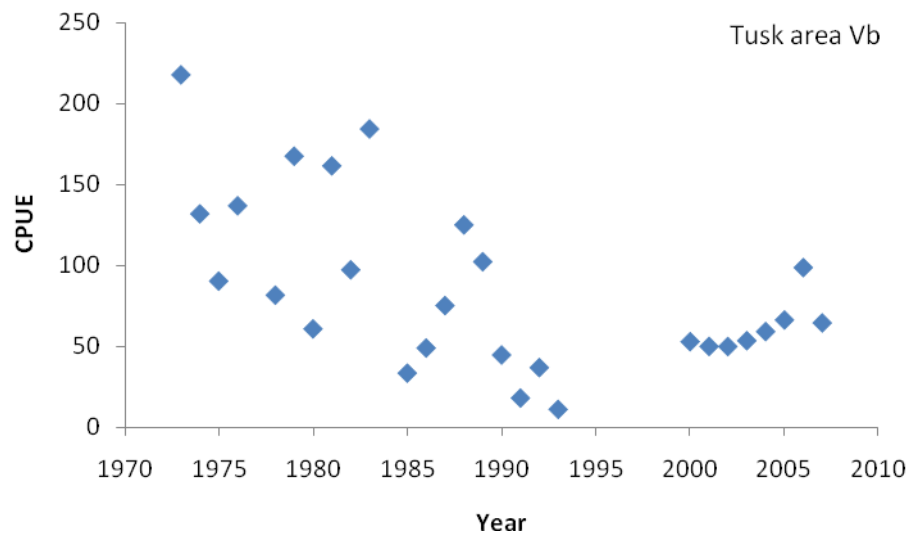


Figure 12. Continued.

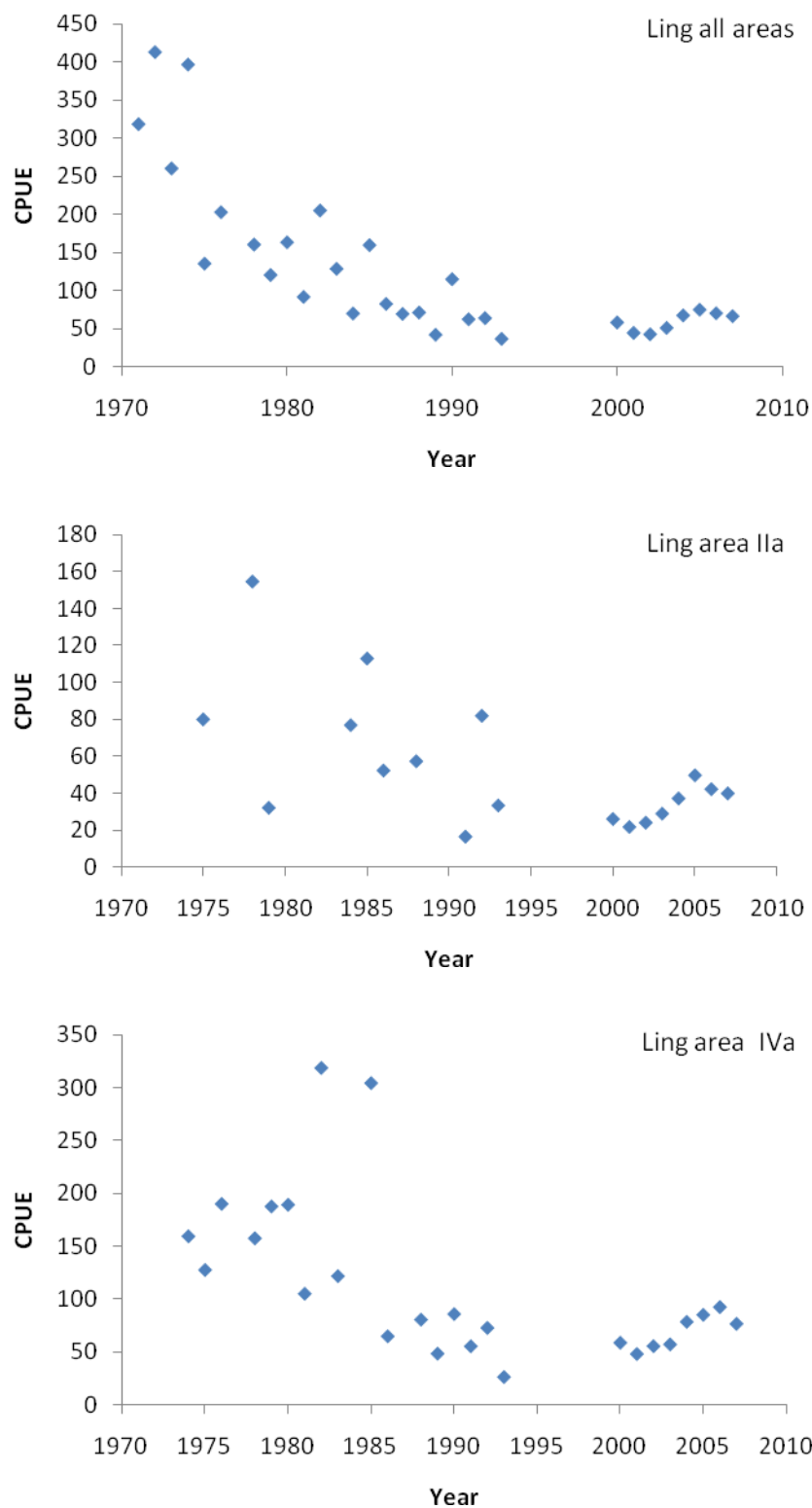


Figure 13. CPUE ([kg/hook] x1000) for ling for all the ICES sub areas combined and separate for the sub areas IIa, IVa, Vb, VIa and VIb for the period 1971 through 1993 and for 2000 through 2007.

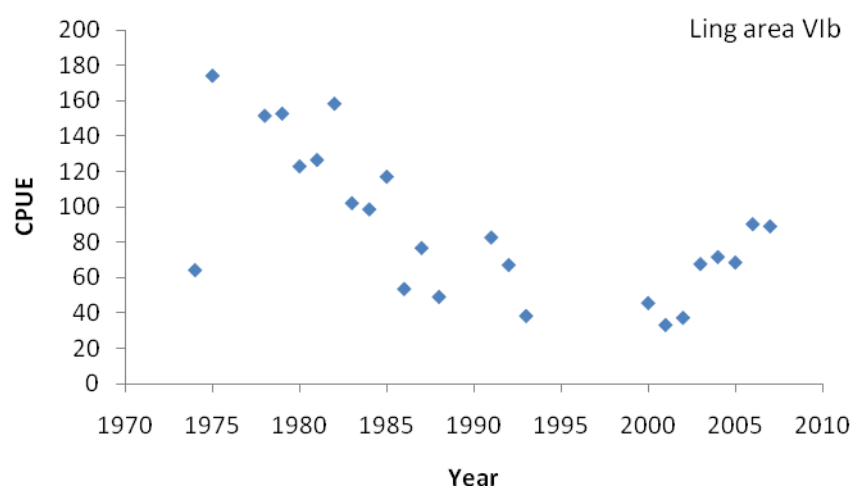
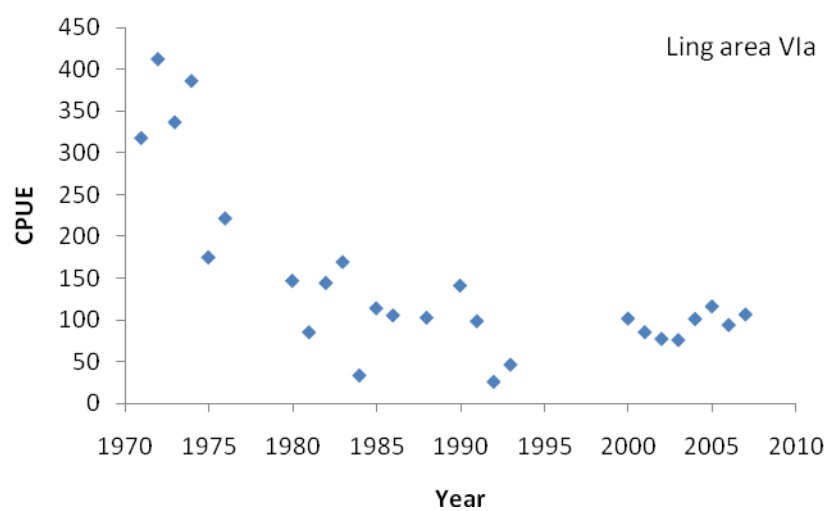
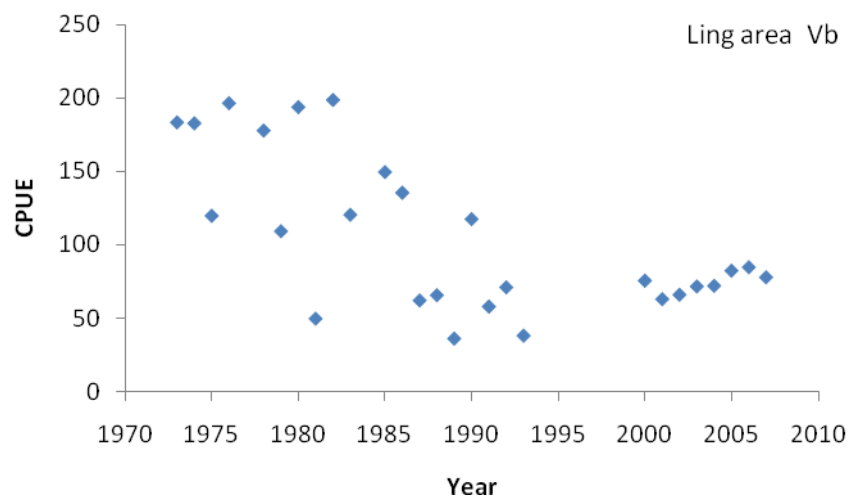


Figure 13. Continued.

